SCULPIN (Cottus) DISTRIBUTION IN THE KOOTENAI NATIONAL FOREST AND NORTHWESTERN PORTIONS OF THE FLATHEAD NATIONAL FOREST, MONTANA

submitted by

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Summary

A total of 39 sculpin (Cottus) samples were collected from waters of the Kootenai National Forest in northwest Montana. Slimy sculpin (Cottus cognatus) were present in 16 of the collections. Torrent sculpin (Cottus rhotheus) appeared in 23 of the samples and sixty-seven sites sampled evidenced no sculpin. Additionally, 3 of 31 re-sample sites contained sculpin while 17 sites within lakes revealed no sculpin. In all, 156 sites were surveyed, principally in the Kootenai River, Tobacco River, and Stillwater River drainages.

Torrent sculpin had a broad distribution geographically, while slimy sculpin were more longitudinally dispersed in the tributary streams of the major rivers in the study area. Based on the limited sampling in this survey, torrent sculpin distribution generally appeared to be restricted to tributary streams of the Kootenai River in close proximity to the main river. However, torrent sculpin were present at distances greater than 5 km from the Kootenai on Tobacco River tributaries, Libby Creek, Fisher River, and Big Creek.

Two sites exhibited potential for sympatry between torrent and slimy sculpin. Hybridization potentially exists between these two species but was not confirmed in this study. The extent of niche partitioning by these species in areas of overlap was not studied.

Sculpin habitat was characterized as riffle or a combination of run/riffle/glide habitat with some degree of cobble substrate. Sculpin were generally found at sites with gradients from 3-4%. Substrate composition is likely an important physical factor influencing sculpin density and distribution and warrants further study.

Species-specific stream habitats were indistinguishable in this study. Qualitative evaluations of stream habitat were used to assess differences between sites. Individual species habitat requirements were similar enough to require that quantitative measures of a number of physical, chemical, and biological conditions be made before distinctions could be determined for individual species.

Electroshocking in conjunction with D-netting was the best method

for sampling sculpin. Alternate sampling methods may be valuable for obtaining additional information.

Introduction

Five species of sculpin (genus Cottus) occur in Montana (Brown 1971, Holton 1990). Sculpin are bottom dwelling fish typically found in rocky substrates of cold water streams. They characteristically have large flattened heads and fan-like pectoral fins. The presence of palatine teeth as well as the number of spiny-rays and soft-rays on the pectoral and pelvic fins are used to distinguish some species. However, sculpin do vary in color and structure, making field identification difficult. Also, occasionally the taxonomy of some species may be in doubt because of the similarity between species due to morphological variation or hybridization (Wydowski and Whitney, 1979). Sculpin are difficult to sample with conventional methods typically used to monitor game fish species in the state. As a result, the distribution and habitat use of each species within the state is uncertain.

Two sculpin species (Cottus confusus and Cottus ricei) are listed as Species of Special Concern in Montana (Genter, 1992). The U.S. Forest Service Northern Region lists these same two sculpin species as Sensitive Species. As such, these two species receive special consideration for conservation lands administered by the forest service.

This field effort of seven weeks and the results is a continuation of six weeks of field work in 1991 to identify the geographic distribution of Cottus in northwest Montana. This study also sought to further define Cottus habitat use in relation to varying degrees of land use and resultant watershed condition. Objectives and methodologies are essentially the same as in 1991 (Gangemi 1992).

In the Kootenai National Forest samples were taken from tributaries of Koocanusa reservoir, the Clark Fork, Kootenai, and Tobacco river systems. Tributaries of the Stillwater River in the Flathead National Forest were also surveyed. This work commenced in July and continued through September of 1992. A number of basins within these watersheds were sampled intensively to determine longitudinal distribution of species in a watershed.

Sculpin are classified as a non-game fish by the Montana Department of Fish, Wildlife and Parks. Funding for research on non-game species is minimal and most distributional information to date has been collected incidentally while electroshocking for game fishes. As a result, the distribution and abundance of sculpin species has not been well documented. The primary purpose of this study is to determine the geographic distribution and relative abundance of sculpin species within the Kootenai National Forest and adjacent portions of the Flathead National Forest.

Study Area

The study area included streams and rivers in northwest Montana (Figures 1 and 2) primarily on lands in the Kootenai National Forest. An additional 7 sites were sampled on streams in the Flathead National Forest in an area adjacent to Kootenai National Forest lands along the Stillwater River (Figures 2 and 3). Study sites were selected based on previous sampling of the watersheds of the Kootenai and Flathead National Forests. Forest maps from these National Forests were used to define watershed boundaries within the study area. A broad spectrum of habitat types were sampled. Most of the sample sites were recommended by Doug Perkinson from the Kootenai National Forest, Don Skaar and Mike Hensler from the Department of Fish, Wildlife and Parks, and Dave Genter from the Montana Natural Heritage Program. Others were deduced from geomorphic features of candidate watersheds.

Methods

Various sampling techniques were experimented with in 1991 (Gangemi 1992) and repeated in 1992. Minnow traps and electroshocking, in combination with the D-net, were the primary techniques utilized in 1992. Minnow traps, measuring 40.6 cm in length and 22.9 cm in height at the center, were used to sample sculpin in lakes. Several holes were drilled in 35mm plastic film canisters and then were filled with canned dog food. One canister, with several large gravel particles (when possible, with attached benthic macroinvertebrates) were placed inside each trap. These baited traps were then used for a minimum 24 hour set.

Most lotic study sites were selectively sampled using a Smithroot model 12 electroshocker. Electroshocker output ranged from 40 to 900 volts direct current depending on the conductivity of the sample stream. The frequency of DC output remained at 60 pulses per second for all streams sampled. Each habitat type present at a particular site (i.e. pool, run, riffle, backwater and various substrate types) was sampled with the shocker to assess the micro-habitat preferences of the sculpin species. D-nets were used in conjunction with the electroshocker.

Sculpin were identified and temporarily labeled in the field. Sample quantity ranged from 5 to 10 sculpin depending on sculpin abundance and the opportunity for longitudinal sampling on the same stream. At the field base, specimens were fixed in formalin for 24 to 36 hours. Sculpin were then thoroughly rinsed and preserved in 70% ETOH. All specimens were delivered to Dr. William Gould of Montana State University (and others) who will verify the field identification. Sculpin for electrophoretic analysis were forwarded to the University of Montana.

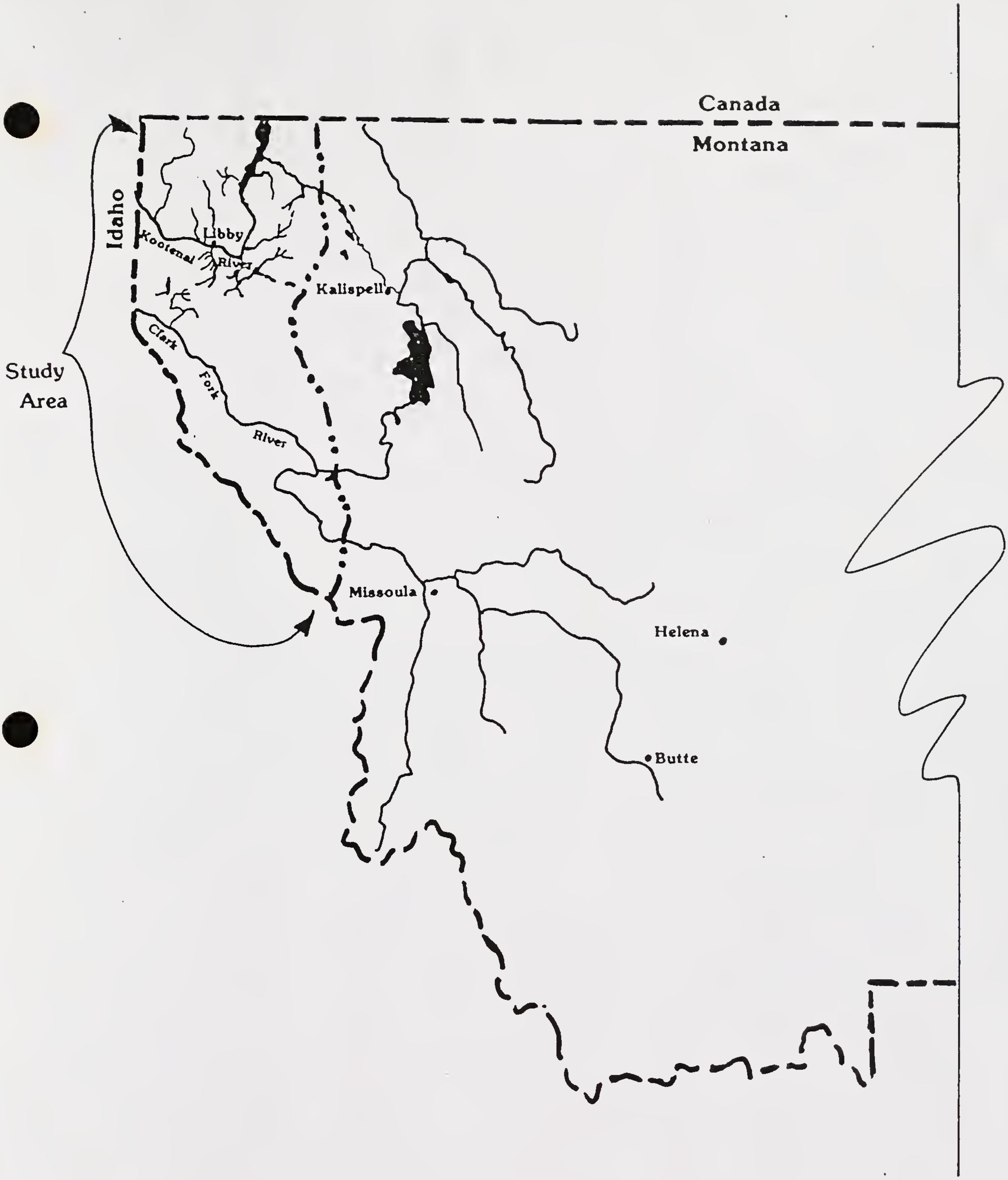


Figure 1: General map of study area in the Kootenai National Forest and northwest portions of the Flathead National Forest.

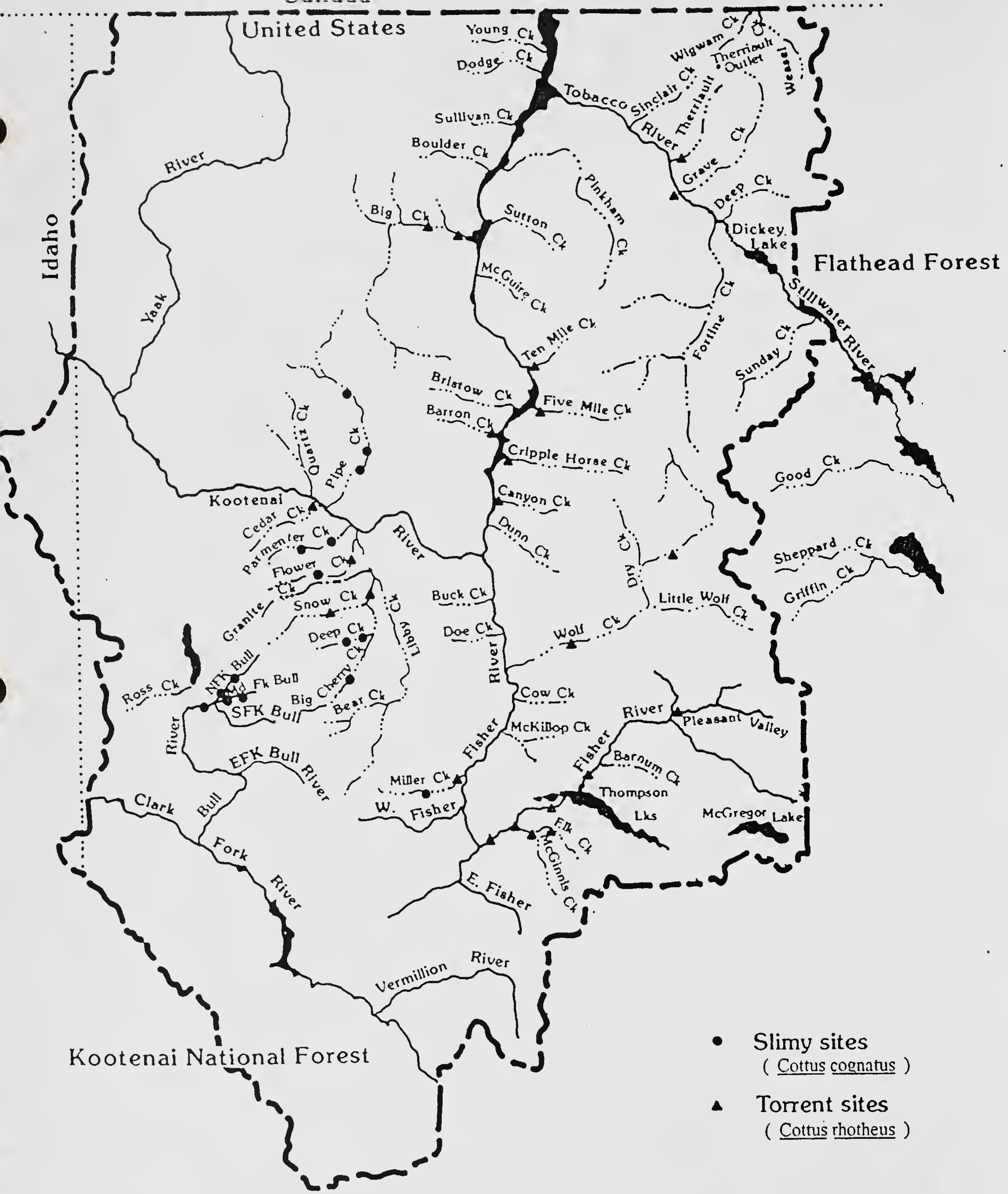


Figure 2: Distribution of slimy sculpin and torrent sculpin in the Kootenai River watershed and lower Clark Fork River watershed in the Kootenai National Forest, and Stillwater drainage in the Flathead National Forest.

Figure 3: Sample sites containing no sculpin in the Kootenai River watershed and lower Clark Fork River watershed in the Kootenai National Forest, and Stillwater drainage in the Flathead National Forest.

Habitat parameters were assessed qualitatively. The parameters and methods of evaluation were as follows:

Sculpin Abundance = quantitatively assessed based on catch efficiency using electroshocker: rare (5 sculpin difficult to catch), uncommon (5 to 10 sculpin caught with concerted effort), common (10 to 15 sculpin caught with minimal effort), abundant (15 or more sculpin caught easily).

Stream Character = dominant stream character where sculpin were captured, i.e., pool, run, riffle or cascades. Pools were identified as the slow, deep water sections; riffles as the steeper gradient sections with high current velocities and white water; runs as the sections with moderate current velocities but with smooth surface water (typically found at the tail of pools and between riffles); cascades as miniature water-falls typically found as water passes over a boulder or some other large structure within the stream channel.

Habitat Length = length of sample site (M = Meters).

Gradient = estimate of percentage of elevation change over distance traveled.

Substrate Composition = qualitative estimate of percentage of area occupied by silt (less than 1/32 inch in diameter), sand (1/32 to 1/4 inch), gravel (1/4 to 3.0 inches), cobble (3.0 to 12.0 inches), boulder (greater than 12.0 inches), and bedrock in the sample reach.

Rooted Aquatic Plants = present (yes) or not present (no).

Filamentous Algae = qualitative assessment of area and thickness of algal mat; rare (difficult to discern algal mat on substrate), uncommon (algal mats are patchy), common (algal mats covering much of substrate but underlying rocks remain discernible), abundant (algal mat covers entire substrate, filaments long, mat greater than 5 cm in thickness, substrate not discernible under mat).

Benthic Macroinvertebrates = quantitative estimate of zoobenthos density on rocks (diameter ranging from 4 to 8 inches) pulled from the water: low (less than 10 organisms), moderate (20 to 40 organisms), or high (50 or more organisms).

Water temperature = temperature at sample site (°F).

Reproduction = evidence of sculpin reproduction based on presence (yes) or absence (no) of young of the year (YOY) sculpin.

Discharge = an estimate of the flow at the sample site.

Overhanging vegetation = percentage of vegetation, overhanging bank, and woody debris (matter) directly over stream surface at a height not greater than 6 feet.

Trout = present (yes) or not present (no).

Land Use Present = visual assessment indicating presence (yes) or absence (no) of land use categories in drainage, i.e., residential (urbanization), agriculture (grazing), forestry (logging), debris thin (roads, fire), mining, channelization (irrigation, roads), dewatering, recreation, undisturbed.

Riparian = Excellent: trees and shrubs (coniferous & deciduous), grass and forbs combined cover over 90 percent of the ground; a variety of species and age classes are represented; growth is vigorous and reproduction is such that continued ground cover and soil stabilization is insured. Good: plants cover 70-90 percent of the ground; shrub species are more prevalent than trees; openings exist between the tree canopy and other plants. Fair: plants cover ranges from 50% - 70 %; seedling reproduction is nil; root mat continuity lacking. Poor: less than 50 percent of the ground is covered; trees are essentially absent; shrubs are in large clumps to non-existing; growth and reproduction is generally poor; root mat discontinuous and shallow.

Results

Species Distribution

Sculpin distribution in the study area appeared to be limited to two species; slimy sculpin (Cottus cognatus), and torrent sculpin (Cottus rhotheus) (Figure 2, and Appendix A). Qualitative assessments of habitat characters for each site are included in appendices B and C. Qualitative assessments of habitat characteristics for sites containing no sculpin are in Appendix D.

Torrent sculpin had the most widespread distribution of the two sculpin species found in this study area although its distribution was restricted to the Kootenai River watershed. This species had the shortest longitudinal range within an inhabited watershed, and were in close proximity to the mainstem Kootenai.

Slimy sculpin were found at sites on tributary streams mainly south, southwest and southeast of Libby. The exception to this was Pipe Creek. Longitudinally, slimy sculpin were found within 1 km of the Kootenai River only on Parmenter Creek. Slimies inhabiting reaches of other tributaries were over 1 km from either the Clark Fork or the Kootenai Rivers. Slimy sculpin were the only species present in the Bull River drainage.

On Kootenai River tributaries above Libby dam, only torrent sculpin were found. All sampled torrents were within 1 km of the main river except for one site on Big Creek, and two sites within the Tobacco River, watershed. Downstream of the dam, other sites with torrents more than 1 km from the Kootenai River included two feeder creeks to Libby Creek and five tributaries to the Fisher River (Figure 2).

A total of 30 sites in 10 tributaries were resampled in 1992. Only three of these tributaries contained sculpin (Appendix E). Five Mile Creek was the only sampled watershed with sculpin within 1 km of the Kootenai River. Graves Creek and the Pleasant Valley/Fisher River sites were further removed from the Kootenai River drainage.

Slimy sculpin and torrent sculpin were found to be sympatric in two tributary streams of the Kootenai River below Libby Dam but for the most part were found isolated from each other longitudinally. In tributaries where both slimy and torrent

sculpin are present, slimy sculpin were generally located in the headwater reaches upstream of the torrent sculpin. Habitat factors influencing this longitudinal segregation of slimy and torrent sculpin were not identified.

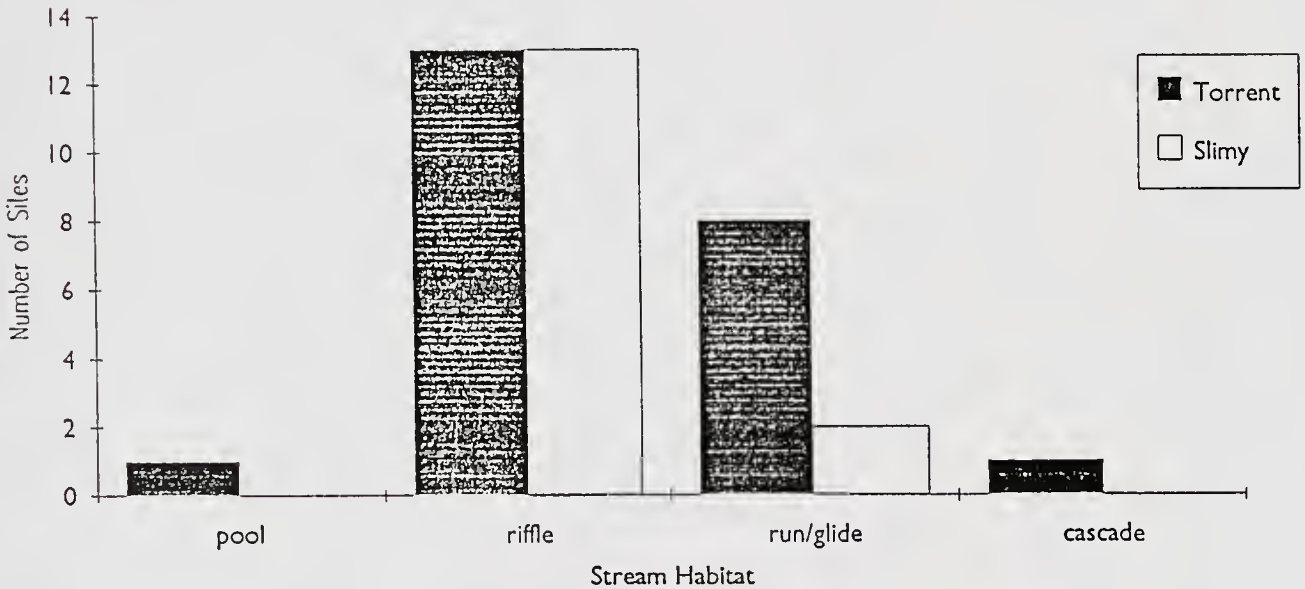
Physical, Biological and Human Influences on Sculpin Distribution

Habitat Type

Habitat types were separated into four categories; pools, runs, riffles and cascades. Distinguishing the point at which a run becomes a riffle was somewhat subjective (see methods) but there appeared to be a preferred location within these four categories by the two sculpin species.

Sculpin, in general, were predominantly found in riffles, and to a lesser degree, in the areas of overlap between runs and riffles (Figure 4). Slimy sculpin were found in riffles 80% of the time compared to 13% in run/glide. Torrent sculpin were located 48% of the time in riffle habitat compared to 39% in run/riffle/glide habitat. Few sculpin species were found in pool habitat although sampling intensity was more extensive in riffle and run/riffle/glide habitat segments since this was where sculpin were most abundant.

Figure 4: Stream character at sample sites containing torrent sculpin, and slimy sculpin in the Kootenai National Forest.



Substrate

Cobble appeared to be the preferred substrate for the two sculpin species, although there were variations in the percentage of cobble versus other substrate sizes (Figure 5). Sites with abundant sculpin populations typically were dominated by cobble substrate. There was a corresponding decline in sculpin abundance at sites where substrate particle size shifted to the gravel and sand size class. It appeared that torrent sculpin were more tolerant of mixed substrate containing some degree of gravel and sand. Sculpin were not present in reaches which did not contain at least some degree of cobble substrate.

Temperature

Temperature was recorded at random times of the day while electroshocking. As a result, comparisons of species specific stream temperatures using statistical analysis were not appropriate. However, temperature trends were distinguishable for each species except at sites where species were rare in occurrence (Figure 6).

Torrent sculpin tended to be found at sites with warmer stream temperatures than those occupied by slimy sculpin. The observed mean temperature at sites containing torrent sculpin was 59.8°F. This was 3.9°F degrees higher than the observed mean temperature at sites containing slimy sculpin. The observed mean temperature where torrent and slimy sculpin were abundant was 68.0°F and 54.8°F respectively.

The warmest temperatures recorded at a site with torrents was 70.0°F and with slimies was 67.0°F. However, torrents were abundant, while slimies were rare at these sites.

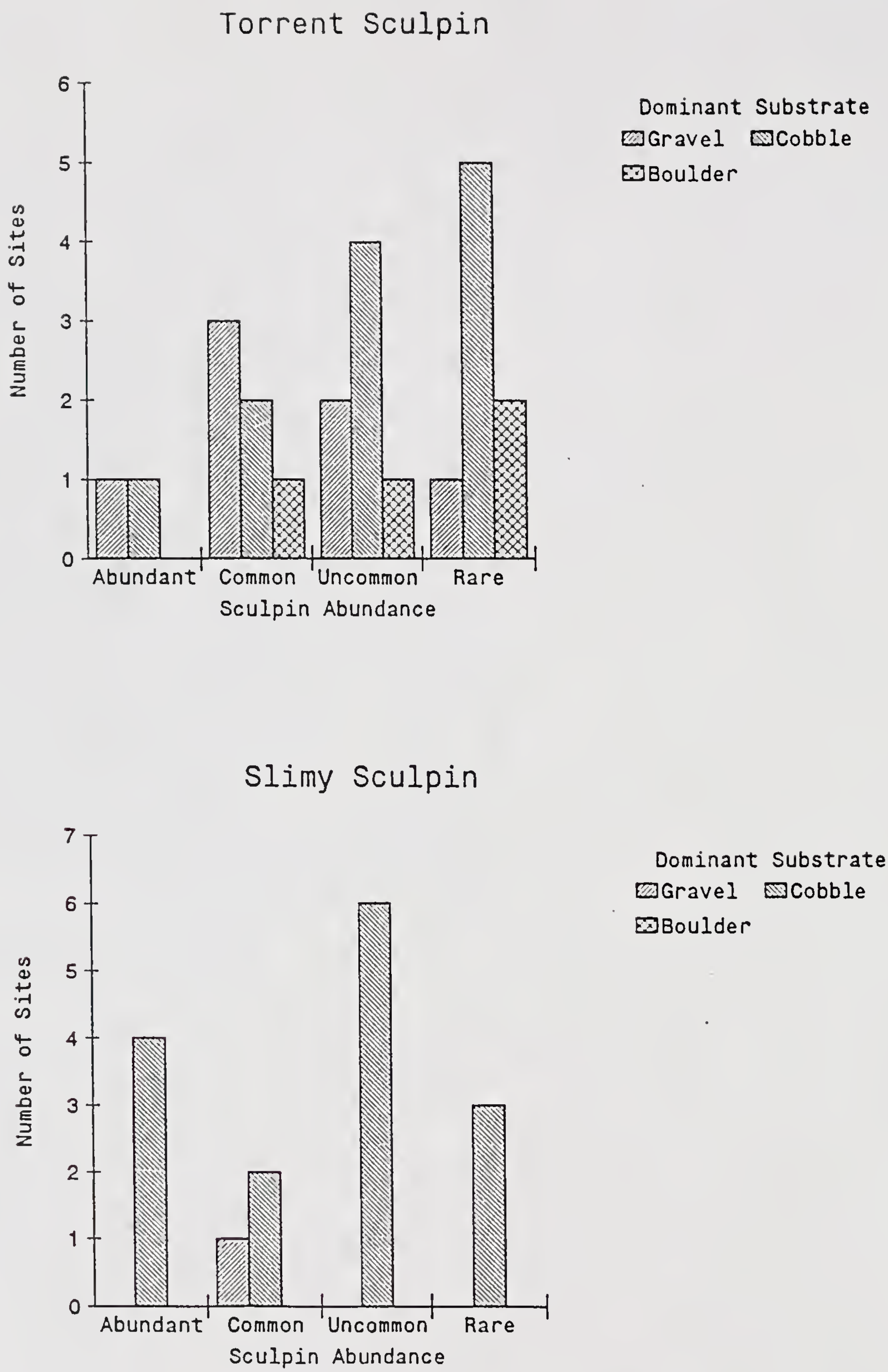


Figure 5: Dominant substrate composition at sample sites containing torrent sculpin, and slimy sculpin at four levels of abundance. Sculpin abundance was assessed quantitatively (see p. 8 for definition of sculpin abundance and substrate composition).

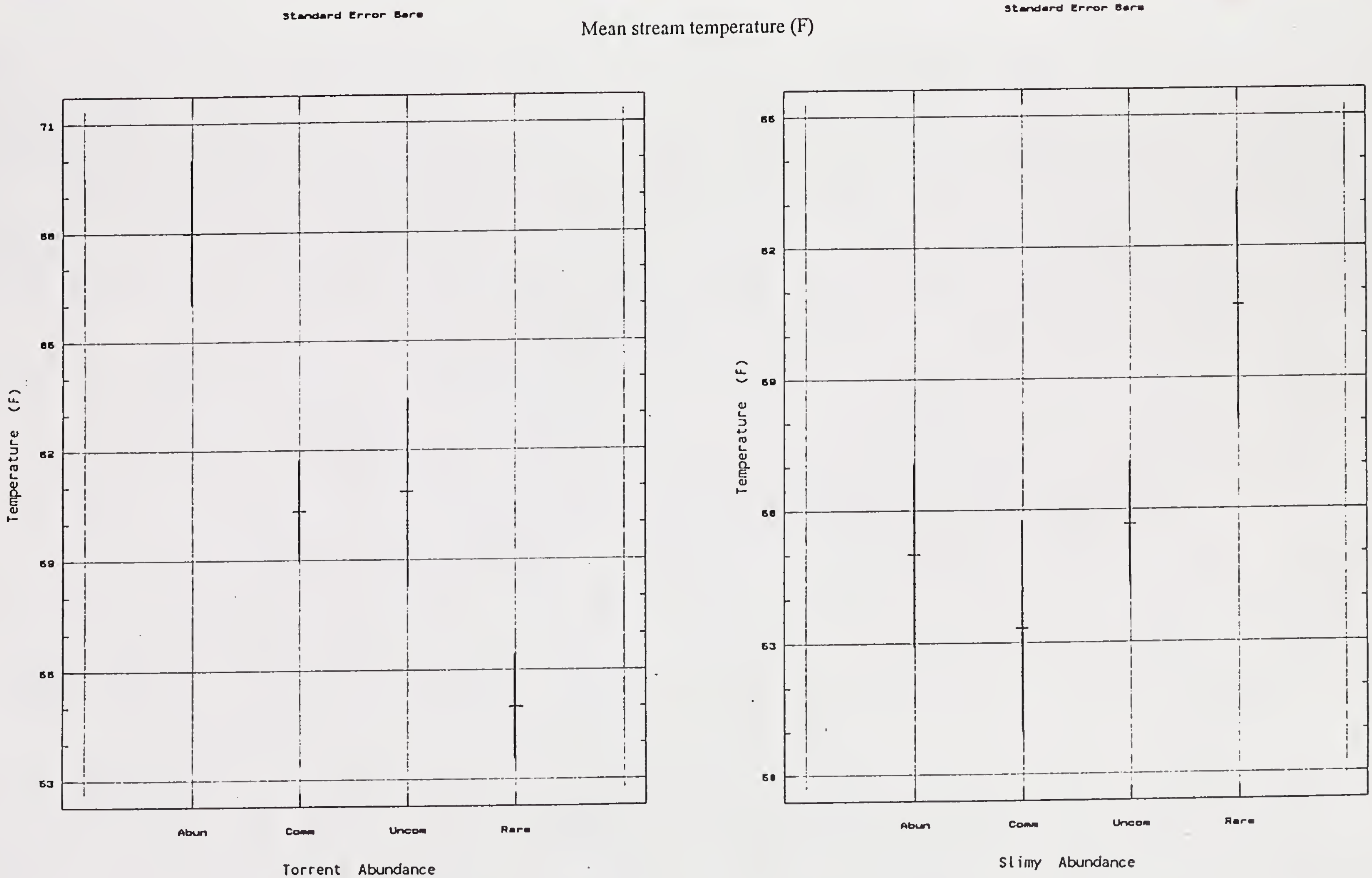


Figure 6: Mean stream temperature (F) at sample sites containing torrent and slimy sculpin at four levels of abundance. Error bars equal 1 standard deviation. Sculpin abundance was assessed quantitatively (see p. 8 for definition of sculpin abundance).

Gradient

Stream gradients appeared to be an important factor influencing sculpin distribution within the study area. Sculpin were found at sites with stream gradients from less than 1% to 7% (Figure 7). In general, both sculpin species were more likely to be found at sites with approximately a 3% to 4% stream gradient. Sculpin were not found at sites with gradients exceeding 7%.

Slimy sculpin were found in stream gradients ranging from 2% to 6%. 81% of the sites containing slimy sculpin had a 3% or >3% stream gradient. Approximately 19% of the sites containing slimy sculpin had stream gradients of 2%.

Torrent sculpin were found at sites with stream gradients ranging from less than 1% to 7% (the widest range). The majority of sites containing torrent sculpin (73.9%) had a 3% or >3% stream gradient. Roughly 22% of the sites containing torrent sculpin had a 2% or <2% stream gradient.

Stream Order

The sampling frequency for each stream order was dictated by the concentration of each stream order in the watershed network, as well as by seasonal factors. The majority of the sample sites occurred on 3rd and 4th order streams. Most 1st and 2nd order streams were either too small to electroshock, exhibited too steep a gradient, or were dry during this sampling season. In addition, far fewer 5th and 6th order streams exist in the study area. Therefore, the number of sample sites for these orders was less than for smaller order streams.

Sculpin were more likely to be found on 4th, 5th, and 6th order streams than at sites on 2nd and 3rd order streams (Figure 8). There was a greater chance of finding sculpin at a given site as stream order increased. Slimy sculpin were most common across the 3 stream orders sampled, being present on 3rd through 5th order streams. Torrent sculpin were found at sites on 3rd, 4th, 5th, and 6th order streams.

Figure 7: Stream gradients at sample sites containing torrent, and slimy sculpin.

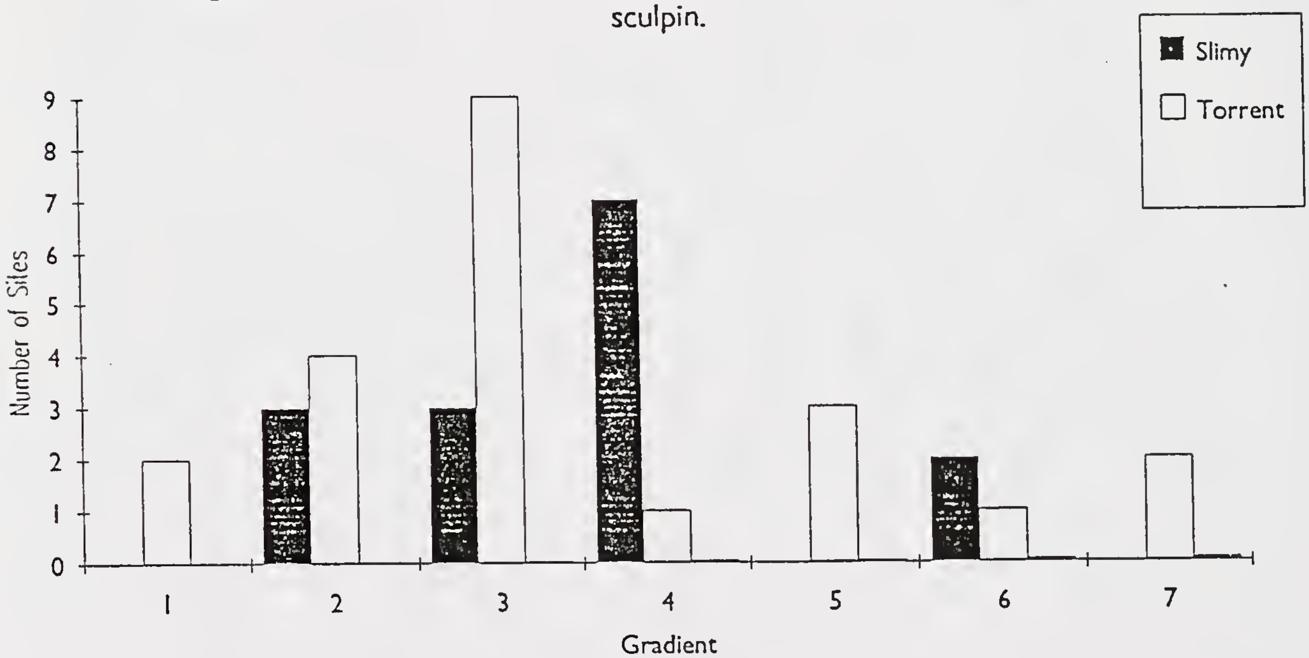
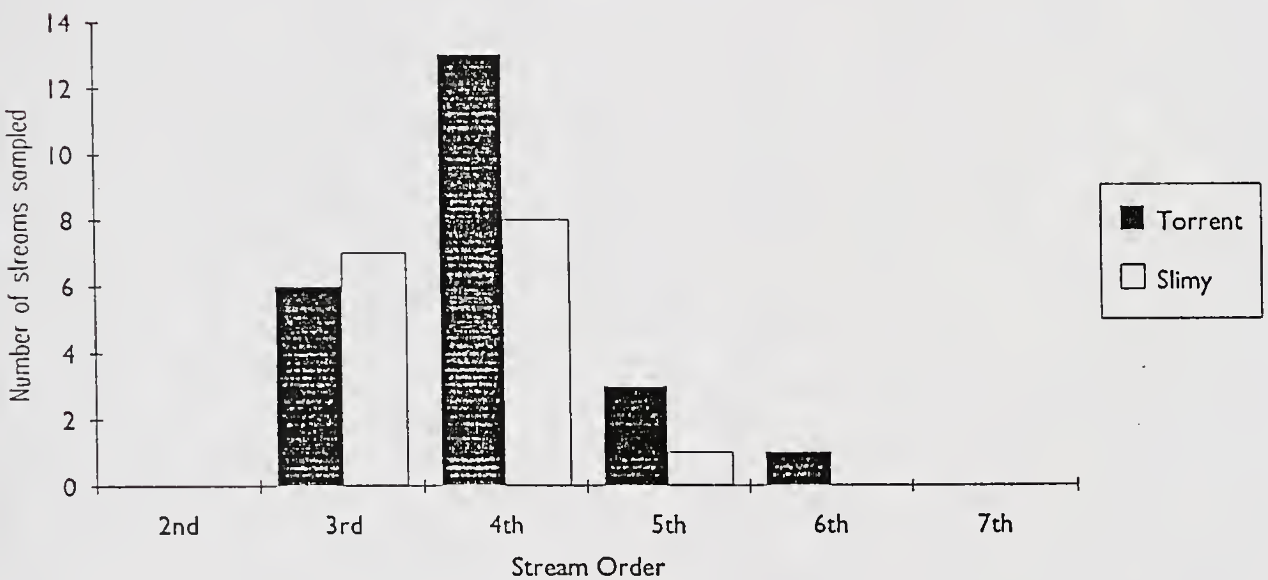
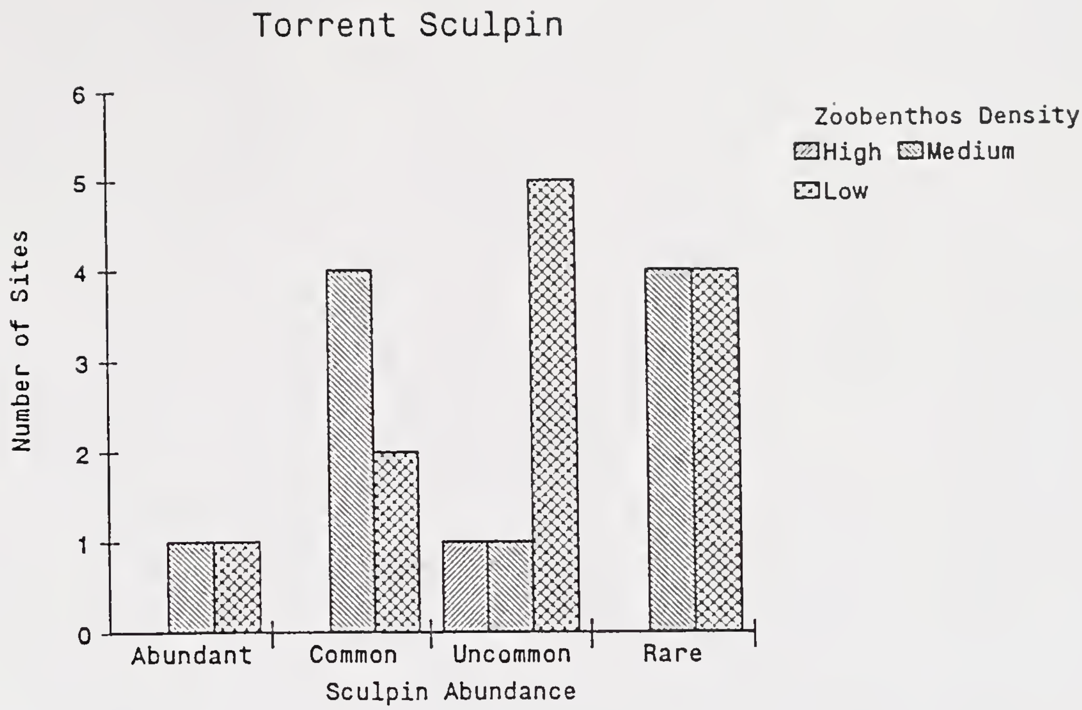


Figure 8: Number of sample sites containing torrent, and slimy sculpin for respective stream orders.





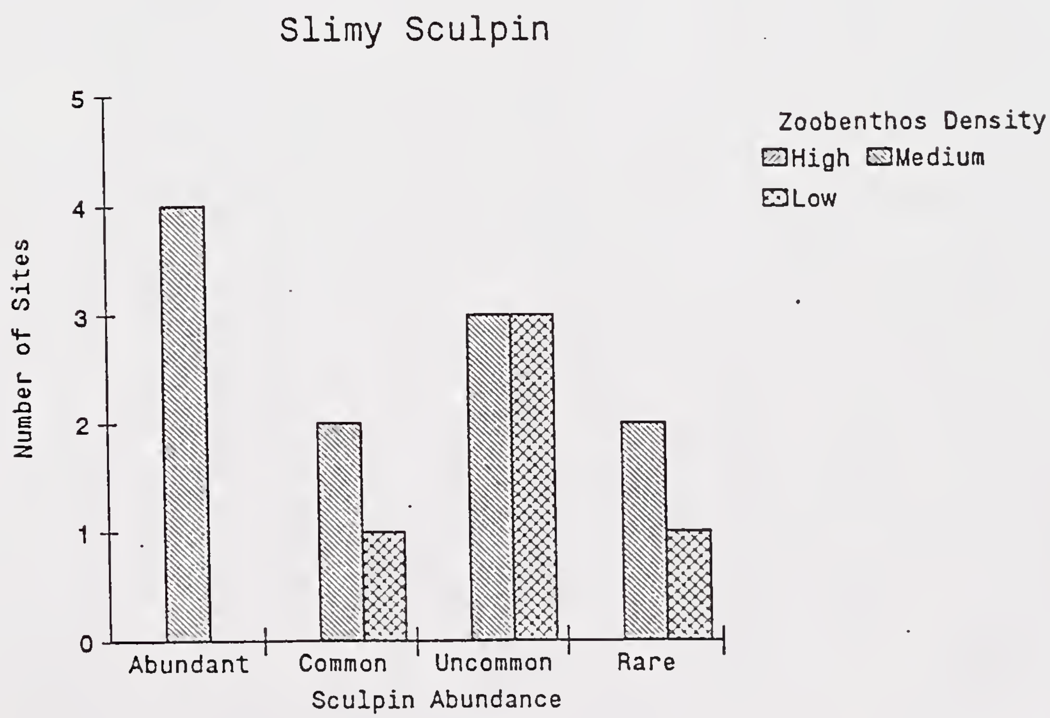


Figure 9: Benthic macroinvertebrate density at sites with four levels of abundance for slimy, and torrent sculpin. Zoobenthos densities and sculpin abundance were assessed quantitatively (see p. 8 for definition of sculpin abundance and zoobenthos density).

Benthic Macroinvertebrates

Benthic macroinvertebrate density ranged from moderate to low at sites where torrent, and slimy sculpin were abundant (Figure 9). There was no dramatic decrease in benthic macroinvertebrate density at sites where sculpin were less numerous or not present at all. At sites where sculpin were not present, benthic macroinvertebrate density ranged from low to high. There is no clear trend or correlation between these variables.

Algal Density

Filamentous algae density ranged from rare to common at sites where torrent, and slimy sculpin were abundant. As torrent and slimy sculpin abundance decreased, algae density varied from common to rare. Also, the reverse trend was noted. There is no clear trend or correlation between these variables.

Reproduction

Reproduction was recorded at sample sites for the two sculpin species present in the study area (Table 1). Slimy sculpin had the highest percentage of sites with young of the year present. Young of the year sculpin tended to occupy backwater areas and were often present in common numbers. Young of the year were more easily stunned with the electroshocker than one or one-plus year fish, but were too small to capture effectively due to their small size relative to the mesh size of the D-nets.

Table 1: Percentage of sample sites with and without reproduction for two sculpin species in the Kootenai National Forest. Reproduction was determined based on the presence or absence of young of the year (YOY) sculpin at the total number of sites for a respective sculpin species between July and September, 1992.

Species	YOY Present	YOY Not Present	Unknown
Slimy	94%	6%	0%
Torrent	65%	30%	5%

Land Use

Both sculpin species field identified in this study, slimy and torrent, were present at sites in which grazing, logging, roads, and channel structures occurred in varying degrees of magnitude within the watershed. Mining activity was the least frequently encountered land use in the study area. Both species were found at sites downstream of hardrock mines. Torrent sculpin were also found at urbanized sites. Essentially there was no site found, or surveyed, which hadn't been subjected to human induced disturbances.

Age Classification

Age classifications were not attempted in this investigation. However, age classifications were determined from a sample of torrent sculpin electroshocked in Libby Creek on October 18, 1991 (see Gangemi, 1992).

Sampling Methodology

The electroshocker, in combination with the D-net were placed directly downstream of the electroshocker. Sculpin immobilized, or partially stunned, or attempting to escape the electrical field were often directed by water flow and subsequently netted. Occasionally checking the D-net yielded a sculpin via the "blind grab." Despite the fact that sculpin were typically capable of eluding the electrical field, this technique proved to be the most effective means of sampling.

Minnow traps were ineffective in catching sculpin. The traps were placed at various lakes within the study area. No sculpin were found within the traps during any sampling interval from 24 to 36 hours (Appendix D).

Discussion

Based on the results of sampling and field identification methods employed, two sculpin species are present in the study area. The distribution of each species varies greatly. Slimy sculpin were the most widespread longitudinally in the study area (similar to 1991 findings). However, this species was mainly present south of Libby. North of Libby it was found only in Pipe Creek. In the Kootenai drainage, in close proximity to the main river, slimy sculpin appear to be displaced longitudinally by torrent sculpin.

Torrent sculpin were found to have a more restricted longitudinal range within the study area. They were typically found in tributary streams of the Kootenai River drainage, in close proximity to the main river. Two exceptions to this were the Fisher River watershed and as Gangemi (1992) found, on Tobacco River tributaries. Here, torrent sculpin were found far from the main river. Sites in the Tobacco watershed with typical low-order stream characteristics did not contain sculpin. Those sites in the Tobacco occupied by torrent sculpin had stream flows affected by most land use disturbances.

Sculpin species in this survey were essentially allopatrically dispersed, with sympatry restricted to a few larger-order watersheds. Habitat of various tributaries in close proximity to major waterways appear to be suitable for slimy sculpin, but slimy sculpin were typically displaced upstream of the torrents on tributaries where both species occurred. This was also noted in the 1991 study (Gangemi 1992).

Factors Influencing Sculpin Distribution

Stream Character

These two sculpin species appear to prefer riffles, and to a lesser degree, the transition area between runs and riffles. Generally, stream segments were not randomly sampled, for habitat preferences. Therefore, concluding that the sculpin species prefer riffle habitat could be a reflection of sampling methodology bias rather than a valid conclusion.

Substrate

Substrate composition appeared to be an important habitat parameter influencing the distribution, and possibly the abundance, of sculpin species found at any one particular sampled reach. However, there were no clear distinctions between species.

Several explanations have been offered to explain the affinity of sculpins for rubble substrates. Interstitial spaces which are common in rubble substrates offer refuge from predatory fish and birds. Sculpin typically attempted to escape the electroshocker by burrowing into the substrate. In addition, rubble substrates typically support higher concentrations of aquatic insects which are thought to be the primary food source for sculpin. (Gangemi 1992, p36) Additionally, this survey found that sculpin seemingly favor cover, shadows, low light intensity, and darker colored substrate. When displaced from cover, sculpin would typically dart away upstream to evade the disturbance. They would then hold momentarily until disturbed again, and double-back to their approximate point of origin. Also, sculpin deposit their adhesive eggs in a mass on the underside of cobbles suspended above the stream bottom, and do not typically have a lengthy (longitudinal) range within a lotic habitat (Scott and Crossman 1973).

Torrent sculpin appeared more capable of tolerating habitat with some degree of finer substrate material than the slimy sculpin. This may, in fact, be an indirect measure of some other habitat parameter influencing torrent distribution (i.e. torrent might prefer warmer stream temperatures, slower velocities, or lower gradients typical of larger-order reaches).

Temperature

Temperatures appear to exhibit some influence on species distribution although species specific tolerance ranges were not determined in this study. Torrent sculpin were typically found at sites with warmer stream temperatures. Slimy sculpin appeared to prefer sites with slightly cooler temperature ranges than did the torrent sculpin (i.e. torrent might prefer warmer stream temperatures, slower velocities, or lower gradients typical of larger-order reaches).

Benthic Macroinvertebrates

Gangemi's 1992 study found no quantitative data linking sculpin abundance with benthic macroinvertebrate density. It was initially hypothesized that a direct relationship would exist between sculpin density and benthic macroinvertebrate density, since the literature states that invertebrates are a major component of sculpin diets (Brown 1971). This lack of a direct link might be due more to sampling methodology rather than results contrary to the hypothesis. Furthermore, zoobenthos have various habitat preferences which may influence sculpin distribution more (i.e. prey-item abundance) than benthic biomass apparently does.

Algal Density

Findings in this study, and those of Gangemi (1992, p38) were again similar; neither study found a direct relationship between algal density and sculpin abundance. Gangemi indicates that as sculpin abundance decreased at a number of sites, algal density increased. Inversely, as algal density decreased, sculpin abundance increased. A possible explanation is that sculpin were cropping the algal community or feeding selectively on macroinvertebrate predators of algal grazers. This would explain lower algal densities at sites where sculpin densities were high. Gangemi attributes the lack of an inverse relationship between sculpin density and algal density at some sites to an algal community dominated by a species not palatable to sculpin. However, it was evident for the most part, that at sites where sculpin were not present, filamentous algae was either rare in abundance or not present.

The inverse relationship between algae and sculpin might better be explained by inefficient sampling methods. High algal densities offer additional concealment for sculpin making it more difficult to net them. This could lead to interpretations that sculpin abundance was low at these sites.

It is also plausible that sculpin prefer, or are relegated to feeding on a particular algal species. Some algae may not be digestible by sculpin or might possibly be too low in necessary proteins for young sculpin to pass through a critical age class. If this were the case then sculpin density and distribution might be greatly influenced by the algal community. (Gangemi, 1992)

Land Use

Some type of human-induced land disturbance has occurred within all watersheds surveyed. The most common form was water pollution resulting from sedimentation. All of the sites were impacted by the cumulative effects of at least two upstream land use practices; most of the sites by more. It was beyond the scope of this survey to judge the tolerance of each species to various forms of disturbance. Alterations which increase sedimentation and temperature and weaken the riparian integrity, could adversely affect the suitability of sculpin habitat at some unknown threshold level.

Sampling Methodology

The electroshocker, in combination with the D-net, was the most effective method for sampling sculpin. Young of the year were typically found in habitat of minimal current (within 2 cm of bottom substrate), good cover (interstitial cobble), and closer to channel edges than larger sculpin. Visually estimating total fish abundance and total habitat in small streams may prove beneficial and an efficient means of complimenting and conducting these surveys (Hankin and Reeves 1986).

Minnow traps proved to be an ineffective sampling device for sculpin despite overnight sets. Sculpin are more active (feeding, etc.) during hours of darkness. Also, it is reported that they favor moving prey as food (Scott and Crossman 1979). Additionally, the lakes sampled were thermally stratified. The minnow traps, for the most part, were set from the lake's shore in warmer epilimnion shallows. Also, the traps were set in areas of seemingly favorable substrate for sculpin. No sculpin were captured using minnow traps.

Glacier and Fire

Other factors which may have had an effect on geographic distribution of sculpin within this study area include glacial action and fire. Glacial Lake Missoula could have effected the distribution of shortheads (Gangemi 1992). Alt and Hyndman (1986) indicate that ice age glaciers approached their maximum extent some 15,000 years ago. These filled the Purcell Valley and advanced south into Idaho crossing the Clark Fork River valley. This ice dam (20 miles wide and 6,000 feet thick) impounded the Clark Fork River to form Glacial Lake Missoula. It also impounded the Kootenai River and formed another glacial lake that likely connected with Glacial Lake Missoula. Valleys such

as that of the Bull River are low enough for these water bodies to have merged. Sediment (varves) records reveal at least 36 cycles of filling and draining of Glacial Lake Missoula. With each flooding cycle, lake boundaries extended deeper into the valley headwaters. At its maximum during the last ice age, the lake Missoula level reached an elevation of about 4,350 feet. These events alone likely influenced the distribution of sculpin, and probably other fish as well.

Fire also may have had an influence on sculpin distribution. Perhaps the recent fire through a portion of Pleasant Valley/Fisher River may offer clues to habitat utilization by sculpin. Some of the lakes in the Eureka area turned alkaline supposedly as a result of fire. This may also be the case with the Sunday Creek drainage, which is void of sculpin. Historical fire information and some water chemistry may aid in explaining species distributional phenomena.

Riparian

Riparian vegetation is of paramount importance in stabilizing stream banks. These plants provide habitat for wildlife, and protect floodplains by impeding flows, slowing water velocity, filtering sediment, and transmitting enormous quantities of water into the air through transpiration. Riparian vegetation assures good water quality by raising the ground water level which, in turn, allows for sustained and regulated flow as well as the recharging of the aquifer. Most riparian zones include sedges, grasses and forbs, shrubs and trees. These flora species provide critical thermal protection: shade in the summer to cool the water, and a thermal blanket in winter to maintain free-flowing streams. From this vegetative zone come the nutrients and organic matter that fuel the overall functioning of the aquatic ecosystem. For these reasons and more it is critical that as much vegetation as possible b e left along river banks and adjacent areas (riparian influence zone). In general the riparian areas observed in this study are in need of restoration. Once a healthy riparian area is again established, perhaps sculpin will inhabit these ecologically preferred areas.

Future Considerations

Future investigations should include, but not be limited to:

- examination of the habitat conditions marking the transition from slimy habitat to torrent habitat on tributary streams where the two species appear to exist in allopatry longitudinally;

- examination of current velocities at a more sensitive scale to distinguish species- specific preferences;

- sampling of invertebrate densities quantitatively and examination of sculpin stomach contents;

- examination of the algal community at specific sites;

- research on the use of AC verses DC power to see which (if either) is more effective on sculpin;

- establishment of contours of past glaciation and glacial lakes;

- establishment of geological faults and plotting of these by contours (elevations);

- analysis of the chemistry of selected waters;

- mapping fire boundaries together with placing fires in chronological order;

- delineation and mapping of Riparian seral conditions;

- examination of lakes and small reservoirs (and other waters) by snorkel and/or scuba census methodologies (similar to, or Hanken and Reeves).

An examination of the preceding information, in contrast to known sculpin distribution, may result in a more refined understanding of sculpin distribution and habitat preferences.

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Appendices

Appendix A : Location of specimen collections on the Kootenai National Forest in northwest Montana. Samples obtained using a Smithroot model 12 electroshocker. The samping period was from July through September 1992.

Sample #	Date	Creek	Map Location 1/4 sec	# specimens	species
1	07/28	P. V. Fisher	T27N R28W sc 13 nw	10	Torrent
2	07/29	N. Fk Bull	T28N R33W sc 14 ne	10	?
3	07/30	Cedar	T31N R32W sc 24 se	01	Torrent
4	07/30	Pipe	T32N R31W sc 35 se	01	Slimy
5	08/01	Bull R	T28N R33W sc 14 ne	10	Slimy
6	08/01	Mid Fk Bull	T28N R32W sc 14 ne	10	Slimy
7	08/01	Mid Fk Bull	T28N R33W sc 12 sw	10	Slimy
8	08/01	N Fk Bull	T28N R33W sc 11 se	10	Slimy
9	08/01	N Fk Bull	T28N R33W sc 12 nw	11	Slimy
10	08/02	Parmenter	T30N R31W sc 08 nw	05	Slimy
11	08/02	Flower	T30N R31W sc 09 se	11	Torrent
12	08/02	Flower	T30N R31W sc 19 se	10	Slimy
13	08/02	Parmenter	T30N R32W sc 12 nw	10	Slimy
14	08/03	Snow	T29N R31W sc 03 ne	10	Torrent
15	08/03	Deep	T29N R31W sc 21 nw	10	Slimy
16	08/03	Deep	T29N R31W sc 22 ne	10	Slimy
17	08/03	Snow	T29N R31W sc 07 ne	06	Torrrent
18	08/04	Big Cherry	T28N R31W sc 09 ne	10	Slimy
19	08/04	Pipe	T32N R31W sc 23 nw	10	Slimy
20	08/04	Pipe	T33N R31W sc 34 se	06	Slimy
21	08/05	Wolf	T30N R28W sc 22 nw	09	Torrent
22	08/05	Wolf	T29N R28W sc 22 nw	08	Torrent
23	08/06	Elk	T26N R28W sc 04 ne	10	Torrent
24	08/06	Elk/McGinnis	T26N R29W sc 01 ne	05	Torrent
25	08/06	Miller	T27N R30W sc 23 se	12	Slimy
26	08/06	Miller	T27N R30W sc 30 ne	10	Torrent
27	08/07	P. V. Fisher	T28N R27W sc 30 ne	09	Torrent
28	08/07	P. V. Fisher	T27N R28W sc 27 nw	10	Torrent
29	08/07	P. V. Fisher	T26N R29W sc 09 ne	08	Torrent
30	08/13	Big	T35N R29W sc 31 ne	06	Torrent
31	08/13	Big	T34N R29W sc 03 nw	06	Torrent
32	08/12	Barron	T32N R29W sc 27 nw	09	Torrent
33	08/17	Ten Mile	T33N R28W sc 27 nw	04	Torrent
34	08/17	Five Mile	T32N R28W sc 17 nw	05	Torrent
35	08/28	Therrault	T35N R26W sc 03 nw	01	Torrent
36	09/03	Graves	T35N R26W sc15 se	05	Torrent

Appendix B-1: Physical and biological stream characteristics at sample sites containing torrent sculpin in the Kootenai National Forest.
* Field assessments (early on) were concluded prior to a finalized field data form.

Creek	Abundnc.	Repro. present	Micro habitat	Invert density	Algal density	Stream order	Gradient percent	Disch. (cfs)	Dominant substrat	Temp (F)	Overhang veg %	Riparian	Trout present	Land use
P. V. Fisher	Uncom	Y	Run/Gld	Low	Abundant	6	2	5	Gravel	64	35	*	Y	1,2,3,7
Ceader	Rare	N	Riffle	Low	Rare	4	3	0.75	Cobble	58	15	*	Y	1,3,7
Ceader	Rare	N	Riffle	Low	Uncom	4	3	0.75	Cobble	58	20	*	Y	1,3,7
Flower	Uncom	Y	Rif/Gld	High	Rare	4	2	1	Cobble	67	5	*	Y	1,3,6,7
Snow	Rare	N	Riffle	Low	Common	4	7	5	Boulder	56	40	*	Y	3,7
Snow	Rare	N	Riffle	Moderate	Rare	4	4	3	Cob/Grv	55	25	*	Y	1,3,7
Wolf	Rare	Y	Pool	Moderate	Common	4	3	1	Cobble	61	30	*	Y	2,3,7
Wolf	Uncom	Y	Run/Gld	Low	Abundant	5	3	1.5	Cobble	68	20	*	Y	2,3,7
Elk	Common	Y	Run/Gld	Low	Common	3	3	0.3	Gravel	54	30	*	Y	2,3,7
Elk/McGns	Uncom	Y	Riffle	Low	Uncom	4	3	2.5	Gravel	56	60	*	Y	2,3,7
Miller	Abundant	Y	Run/Gld	Low	Uncom	3	1	0.1	Gravel	66	40	*	Y	3,7
P. V. Fisher	Common	Y	Run/Gld	Moderate	Abundant	4	2	0.75	Cobble	64	15	Poor	Y	2,3,7
P. V. Fisher	Abundant	Y	Riffle	Moderate	Common	4	3	1.5	Cobble	70	0	Poor	N	3,7
P. V. Fisher	Common	N	Rin/Gld	Moderate	Common	5	1	3.5	Gravel	61	25	Poor	N	1,3,7
Canyon	Rare	?	Cascade	Moderate	Rare	3	5	0.5	Cobble	55	0	Poor	Y	2,3,5,7
Cripple Hrs	Rare	N	Riffle	Moderate	Common	3	3	0.75	Boulder	58	0	Poor	Y	7
Big	Common	Y	Riffle	Moderate	Abundant	4	5	6	Cobble	61	20	Good	Y	3,7
Big	Common	Y	Riffle	Low	Abundant	4	5	7	Boulder	65	15	Fair	Y	3,7
Barron	Common	Y	Run/Gld	Moderate	Abundant	4	2	0.25	Gravel	62	2	Poor	Y	3,7
Ten Mile	Uncom	Y	Riffle	Low	Abundant	3	7	0.75	Cobble	56	0	Poor	Y	3,7
Five Mile	Uncom	Y	Riffle	Low	Abundant	4	6	1.5	Boulder	67	0	Poor	N	1,2,3,7
Therraiult	Rare	N	Rif/Gld	Low	Common	3	3	0.5	Gravel	47	60	Fair	Y	1,2,4,5,
Graves	Uncom	Y	Run/Gld	Moderate	Abundant	5	3	4	Cobble	50	25	Poor	N	1,2,3,4,

Appendix B-2 : Physical and biological stream characteristics at sample sites containing slimy sculpin in the Kootenai National Forest.
* Field assessments (early on) were concluded prior to a finalized field data form.

Creek	Abundnc.	Repro. present	Micro habitat	Invert density	Algal density	Stream order	Gradient percent	Disch. (cfs)	Dominant substrat	Temp (F)	Overhang veg %	Riparian	Trout present	Land Use
Bull R.	Abundant	Y	Riffle	Moderate	Rare	5	3	2	Cobble	50	20	*	Y	3,7
Mid Fk Bull	Common	Y	Riffle	Moderate	Uncom	4	4	1.5	Cobble	50	50	*	Y	3,7
Mid Fk Bull	Common	Y	Riffle	Low	Rare	4	2	<1.0	Cobble	52	25	*	Y	3,7
N. Fk Bull	Abundant	Y	Riffle	Moderate	Uncom	4	4	1	Cobble	57	20	*	Y	3,7
N. Fk Bull	Rare	Y	Riffle	Moderate	Common	4	6	1	Cobble	57	0.02	*	Y	3,7
Parmenter	Uncom	Y	Riffle	Moderate	Rare	4	6	2.5	Cobble	62	25	*	Y	1,6,7
Parmenter	Uncom	Y	Riffle	Low	Uncom	4	4	1.5	Cobble	53	20	*	Y	3,6,7
Flower	Uncom	Y	Riffle	Low	Uncom	4	4	2.5	Cobble	56	20	*	Y	3,7
Deep	Uncom	Y	Riffle	Moderate	Rare	3	3	1	Cobble	54	35	*	Y	3,7
Deep	Abundant	Y	Riffle	Moderate	Uncom	3	4	1.5	Cobble	53	50	*	Y	3,7
Big Cherry	Uncom	Y	Run/Gld	Moderate	Uncom	3	4	1	Cobble	52	5	*	Y	3,7
Pipe	Abundant	Y	Riffle	Moderate	Common	3	3	4	Cobble	59	25	*	N	1,2,3,7
Pipe	Rare	Y	Riffle	Moderate	Uncom	4	4	3	Cobble	57	60	*	Y	1,3,7
Pipe	Rare	N	Rif/Pool	Low	Rare	2	2	2.5	Cobble	67	20	*	Y	1,3,7
Miller	Common	Y	Run/Gld	Moderate	Common	2	2	0.5	Gravel	58	30	*	Y	3,7

Appendix B-3 : Physical and biological stream characteristics at sample sites not containing sculpin in the Kootenai and Flathead National Forests,
* Field assessments (early on) were concluded prior to a finalized field data form.

Creek	Micro habitat	Invert density	Algal density	Stream order	Gradient percent	Disch (cfs)	Dominant substrat	Temp (F)	Overhang veg %	Riparian	Trout present	Land use
Ross abv falls	Rif/Run	Moderate	Uncom	6	3	2	Gravel	47	8	Poor	Y	3,7
Ross blw falls	Rif/Run	Moderate	Rare	6	4	2	Cob/Bldr	52	10	Fair	Y	3,6,7
Barnum	Rif/Run	Low	Common	5	3	1.2	Cobble	54	60	*	Y	3,7
N. Fk Bull	Cscd/Rif	Low	Rare	4	7	1.5	Boulder	59	10	Fair	Y	3,7
Big Cherry	Riffle	Low	Common	5	3	6	Cobble	67	10	*	Y	1,2,3,6,7
Dry	Riffle	Low	Rare	3	2	0.1	Cobble	52	20	*	Y	2,3
Wolf	Pool	Moderate	Abundant	4	2	1.5	Sand	57	15	*	Y	2,3,7
Cow	Riffle	Low	Uncom	3	3	0.25	Cob/Grv	52	45	*	Y	3,7
Buck	Cascade	Low	Rare	3	8	0.1	Cobble	56	60	*	Y	3
McGinnis	Run/Gld	Low	Rare	3	3	0.5	Snd/Grv	62	60	*	Y	2,3,7
McGinnis	Run/Gld	Low	Common	2	4	0.25	?	44	40	*	Y	2,3,7
Elk	Riffle	Low	Common	2	4	0.5	Gravel	57	65	*	Y	2,3,7
McKillop	Riffle	Low	Uncom	4	3	0.2	Gravel	54	85	Good	Y	3,7
McKillop	Riffle	Low	Rare	4	3	0.2	Gravel	53	85	Good	Y	3,7
P. V. Fisher	Pool	High	Rare	2	<1	.05 ?	Silt	60	20	Poor	N	2,3,6,7
Dunn	Pool	Moderate	Common	4	2	0.5	Gravel	57	40	Poor	Y	7
Dunn	Run/Gld	Low	Common	4	3	0.75	Cobble	57	65	Good	Y	3,7
Big	Riffle	High	Abundant	4	5	6	Cobble	58	30	Fair	Y	3,7
Big	Riffle	Moderate	Abundant	4	6	4	Cobble	57	35	Good	Y	3,7
Boulder	Pool	Low	Abundant	4	8	3	Boulder	55	20	Good	Y	3,4,5,6,7
Barron	Rif/Run	Moderate	Abundant	3	4	0.75	Cobble	61	75	Fair	Y	3,7
Barron	Run/Gld	Moderate	Abundant	3	3	0.5	Gravel	60	70	Good	Y	3,7
Bristow	Run/Gld	Moderate	Common	4	3	0.75	Cobble	54	65	Good	Y	3,4,7
Bristow	Run/Gld	Moderate	Abundant	4	6	0.75	Boulder	56	75	Good	Y	2,3,4,7
W. Fk Big	Riffle	Moderate	Abundant	4	5	2.5	Cobble	54	60	Good	Y	3,7
Big	Rif/Run	Low	Abundant	4	6	4	Boulder	57	40	Good	Y	3,7
Ten Mile	Run/Gld	Moderate	Abundant	3	6	0.75	Cobble	55	40	Good	Y	3,7
Five Mile	Riffle	Moderate	Abundant	4	4	1	?	61	65	Good	Y	1,2,3,7
Sutton	Riffle	Moderate	Abundant	4	5	1.75	Cobble	56	40	Fair	Y	3,4,5,7
McGuire	Riffle	Common	Abundant	4	6	1.5	Grv/Cbl	55	0	Poor	N	3,5,7
McGuire	Riffle	Common	Common	4	10	1.5	Boulder	54	60	Good	Y	3,7
Weasel	Run/Gld	Rare	Uncom	4	5	0.5	Cob/Grv	40	10	Fair	Y	2,3,4,7
Graves	Riffle	High	Common	3	6	1.5	Cobble	40	40	Fair	Y	3,7
Graves	Riffle	High	Abundant	4	5	3	Gravel	43	40	Fair	Y	3,5,7
Graves	Riffle	Low	Abundant	5	4	5	Gravel	50	10	Poor	Y	1,2,3,4,5,6,7
Wigwam	Riffle	Low	Common	4	6	6	Cobble	42	40	Fair	Y	2,3,7
Wigwam	Riffle	Low	Common	3	4	3	Gravel	43	30	Fair	N	2,3,7
Therrault out-lt	Riffle	Low	Common	1	4	1	Cobble	55	50	Fair	Y	2,3,7
Graves	Riffle	Low	Common	5	6	7	Cobble	45	45	Fair	Y	1,2,3,4,5,7

Appendix B-3 cont. : Physical and biological stream characteristics of sample sites not containing sculpin in the Kootenai and Flathead National Forests. * Field assessments (early on) were concluded prior to a finalized field data form.

Creek	Micro habitat	Invert density	Algae density	Stream order	Gradient percent	Disch. (cfs)	Dominant substrat	Temp (F)	Overhang veg %	Riparian	Trout present	Land use
Sunday	Riffle	Low	Common	4	6	5	Cobble	56	50	Fair	y	1,2,3,5,7
Sunday	Riffle	Low	Common	4	7	5	Cobble	54	50	Fair	Y	1,2,3,4,5,7
Sunday	Riffle	Low	Common	3	7	1	Cobble	48	65	Fair	Y	3,4,5,7
Therrault	Riffle	Low	Abundant	3	3	0.5	Gravel	47	15	Poor	Y	1,2,4,5,6,7
Therrault	Riffle	Low	Abundant	3	2	0.75	Gravel	47	80	Fair	Y	1,2,4,5,6,7
Pinkham	Run/Gld	Low	Abundant	4	4	1	Gravel	47	75	Fair	Y	1,2,3,4,5,7
Pinkham	Run/Gld	Low	Abundant	4	3	0.75	Gravel	55	65	Fair	Y	1,2,3,4,5,7
Pinkham	Riffle	Low	Abundant	4	3	0.75	Gravel	53	40	Poor	N	2,3,4,7
Pinkham	Riffle	Common	Common	4	5	1	Cobble	46	50	Poor	Y	2,3,4,5,7
Deep	Riffle	Low	Uncom	3	8	2	Boulder	43	45	Fair	Y	2,3,4,5,7
Deep	Riffle	Low	Common	3	3	3	Cobble	44	25	Fair	Y	2,3,4,5,6,7
Deep	Riffle	Low	Abundant	3	4	2	Cobble	45	5	Poor	Y	2,3,4,5,6,7
Deep	Riffle	Low	Abundant	3	3	2	Gravel	48	45	Poor	Y	1,2,3,4,5,6,7
Sinclair	Riffle	Moderate	Common	3	4	1	Cobble	50	40	Good	Y	1,2,3,5,7
Sinclair	Pool	Low	Common	3	2	0.5	Gravel	53	35	Fair	Y	1,2,3,4,5,6,7
Sinclair	Run/Gld	Moderate	Common	3	3	0.5	Gravel	54	25	Poor	Y	1,2,3,4,5,6,7
Dodge	Riffle	Moderate	Common	4	3	0.75	Cobble	48	60	Poor	Y	1,2,3,4,5,7
Dodge	Pol & R-	Moderate	Common	4	3	1.5	Gravel	50	15	Poor	Y	1,2,3,4,5,7
Dodge	Cascade	Moderate	Abundant	4	8	1.75	Cobble	51	15	Fair	Y	1,2,3,4,5,6,7
Sullivan	Riffle	Moderate	Common	4	8	1	Boulder	47	30	Poor	Y	2,3,4,7
Sullivan	Cascade	Moderate	Common	4	8	1.75	Boulder	50	40	Fair	Y	2,3,4,5,6,7
Sullivan	Cscd & P	Moderate	Abundant	4	8	0.75	Bedrock	52	45	Fair	Y	2,3,4,7
Flathead Nat. Forest												
Sheppard	Riffle	Common	Abundant	4	3	4	Cobble	47	40	Poor	Y	1,2,3,4,6,7
Sheppard	Pol/Rn/G	Moderate	Abundant	4	2	3	Cobble	48	10	Poor	N	1,2,3,4,5,7
Griffin	Riffle	Moderate	Abundant	4	4	5	Boulder	47	20	Fair	Y	2,3,4,7
Griffin	Riffle	Moderate	Abundant	4	3	4	Cobble	47	10	Poor	Y	2,3,4,6,7
Good	Riffle	Moderate	Abundant	4	3	3	Boulder	48	30	Fair	Y	2,,3,4,7
Good	Run/Gld	Low	Abundant	5	3	5	Cobble	56	20	Poor	Y	1,2,3,4,5,6,7
Good	Riffle	Low	Abundant	5	4	6	Boulder	57	15	Fair	Y	1,2,3,4,5,6,7

Appendix C : Location of sculpin re-sample sites on the Kootenai National Forest in northwest Montana. Samples obtained using a Smithroot model 12 electroshocker. The sampling period was from July through September 1992. None found is N/F.

Sample #	Date	Creek	Map Location 1/4 sec	# Specimens	species
001	07/28	P. V. Fisher	T27N R28W sc 13 nw	10	Torrent
002	08/07	P. V. Fisher	T28N R25W sc 23 se	00	N/F
003	08/07	P. V. Fisher	T28N R27W sc 30 ne	09	Torrent
004	08/07	P. V. Fisher	T27N R28W sc 27 nw	10	Torrent
005	08/07	P. V. Fisher	T26N R29W sc 09 ne	08	Torrent
006	08/08	Cripple Horse	T31N R29W sc 01 sw	00	N/F
007	08/08	Cripple Horse	T31N R29W sc 02 se	00	N/F
008	08/11	Bristow	T32N R29W sc 10 sw	00	N/F
009	08/11	Bristow	T32N R29W sc 15 ne	00	N/F
010	08/17	Five Mile	T32N R28W sc 17 nw	05	Torrent
011	08/17	Five Mile	T32N R27W sc 14 sw	00	N/F
012	08/18	Sutton	T35N R28W sc 29 se	00	N/F
013	08/18	Sutton	T35N R28W sc 30 se	00	N/F
014	09/01	Sullivan	T36N R28W sc 24 ne	00	N/F
015	09/01	Sullivan	T36N R28W sc 20 nw	00	N/F
016	09/01	Sullivan	T36N R28W sc 20 ne	00	N/F
017	08/25	Graves	T37N R24W sc 32 nw	00	N/F
018	08/25	Graves	T36N R25W sc 12 nw	00	N/F
019	08/25	Graves	T35N R26W sc 14 sw	00	N/F
020	08/26	Graves	T36N R25W sc 33 sw	00	N/F
021	08/26	Graves	T36N R25W sc 14 nw	00	N/F
022	09/03	Graves	T35N R26W sc 15 se	05	Torrent
023	08/27	Sunday	T33N R24W sc 18 nw	00	N/F
024	08/27	Sunday	T33N R24W sc 25 nw	00	N/F
025	08/27	Sunday	T33N R25W sc 33 se	00	N/F
026	08/31	Deep	T35N R25W sc 14 se	00	N/F
027	08/31	Deep	T35N R25W sc 15 sw	00	N/F
028	08/31	Deep	T35N R25W sc 20 se	00	N/F
029	08/31	Deep	T35N R25W sc 30 se	00	N/F
030	10/04	Young	T37N R28W sc24 nw	00	N/F

Appendix D: Locations and dates for lakes sampling on the Kootenai National Forests in northwest Montana. Minnow traps were set for 24 to 36 hours. No sculpin were captured. The sampling period was from August through September 1992. Surface temperatures (ferinheit) were recorded. None found = N/F.

Site #	Date	Lake	F	Map location (1/4 sec)	# specimens	species
01	08/24	Rock	64	T35N R26W sc06sw	0	N/F
02	08/24	Frank	65	T35N R26W sc07sw	0	N/F
03	08/24	Tetrault	67	T37N R27W sc28ne	0	N/F
04	08/24	Tetrault	67	T37N R27W sc28nw	0	N/F
05	08/24	Sophie	66	T37N R27W sc21sw	0	N/F
06	08/25	Dickey	65	T34N R24W sc15ne	0	N/F
07	08/25	Dickey	65	T34N R24W sc15sw	0	N/F
08	08/26	Glen	59	T36N R26W sc22nw	0	N/F
09	08/26	Glen	59	T36N R26W sc22nw	0	N/F
10	08/26	Murphy	59	T34N R25W sc08nw	0	N/F
11	08/26	Murphy	59	T34N R25W sc05sw	0	N/F
12	09/15	McGregor	63	T26N R25W sc09se	0	N/F
13	09/15	McGregor	63	T26N R25W sc05se	0	N/F
14	09/15	Mdl. Thmpsn	61	T26N R27W sc04n	0	N/F
15	09/16	Mdl. Thmpsn	61	T26N R27W sc04sw	0	N/F
16	09/16	Upr. Thmpsn	61	T27N R27W sc30se	0	N/F
17	09/16	Upr. Thmpsn	61	T27N R27W sc30sw	0	N/F